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Unconventional Emergency System Characteristics and Emergency Decision-making Analysis

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Abstract

Compared with conventional emergency, unconventional emergency has typical unconventional characteristics and its system characteristics and emergency decision-making processes and methods are also very special. In order to making a deeper understanding the system characteristics and emergency decision-making mechanism of unconventional emergency, based on the definition and features analysis, the principle of entropy and dissipative structure theory to explain unconventional emergency system status characteristics, this paper analysis of unconventional emergencies and emergency management in the process of entropy state changes; further analysis temporal frame of unconventional emergency decision-making. Analysis shows that the unconventional emergencies happened and management is an Open dissipative system. System entropy changing by increased entropy factors ZS, negative entropy factor FS and system bearing capacity C combined action. Corresponding unconventional emergency system in the process of incubation period, initiation period, outbreak period, evolution period or recovery period and disappeared period, emergency decision-making work of temporal framework can be divided into warning precaution, crisis identification and isolation, integrated response and disposal measures four links.

Keywords: unconventional emergency system, entropy principle, emergency decision-making, temporal framework.

Nomenclature

dS	total entropy of the system
d_eS	the exchange entropy flow of the system and the surrounding environment
d_iS	the entropy flow produced by changes of the internal system

1. Introduction

In recent years, the unconventional emergencies relentlessly entered people's field of vision along with the social development and the unceasing change of natural environment, they are constantly improve and expand in the countries all over the world, which seriously affected the economic development, social stability and ecological health. At the same time, as the increasing degree of social organization system ,the correlation and dependence between different social , locality and regular events can easily turn to the serious influence and harm of unconventional emergencies, It's the urgent task at present academia and government to systematic and deeply study the development and evolution of unconventional emergency mechanism and emergency decision-making method of occurrence, and construct suitable for China's national conditions of unconventional emergency decision-making model and emergency management system. So unconventional

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emergencies is presented in this paper based on the analysis of the definition and characteristics, using the complex system science analysis of characteristics of unconventional emergency system and emergency decision-making temporal framework, in order to provide theoretical reference to realize effective emergency decision-making and management of unconventional emergencies.

2. The definition and features analysis of unconventional emergency

The unconventional emergency refers to the event which has inadequate precursor, apparent complexity, potential, secondary and serious destruction and it is hardly to deal with by the conventional management method. Compared with conventional emergency, the unconventional characteristic of unconventional emergency mainly reflects in three aspects:

(1) The first layer is the factors which cause the event are not obvious precursor, complex and changing. And the development and evolution of unconventional emergency are full of stages and links which have uncertainty and unconventional characteristic.

(2) The second layer is that it caused great personnel and property damage, which influence citizens' production, life order and endanger public safety and even national security seriously.

(3) The third layer is that the unconventional emergency is difficult to deal with because people lack of experience of the occurrence and understanding of the development and evolution of it. Thus it must deal with by taking special methods.

But the unconventional characteristic unconventional emergency is a relative, vague and hard to quantitative concepts. Therefore, there is not a clear boundary between unconventional emergency and conventional emergency. And they are contacted and can transform into each other. According to the different places, different time and different trigger and different main parties of occurrence, the emergencies can be divided into conventional emergency or unconventional emergency. Such as the particularly serious gas accident in coal mine in our country, it has strong devastating effects and consequences. Between 2000 and 2012, there are 44 gas accidents and more than 30 people die in each accident. About 3.7 accidents happen in each year and the occurrence frequency is high, the cause of the corresponding mechanism and the evolution knowledge are abundant. What's more, in emergency disposal aspect it is in the country's routine management scope, so it has the conventional property. However in different spaces and time condition, its causing factors are uncertain and complex and for one coal mine it has little or no experience on particularly serious gas accident, so it lacks of the knowledge on the evolution and experience in corresponding disposal. Therefore, it prone to happen the secondary disasters and it also characterized by unconventional property. In addition, some unconventional emergencies could turn into the conventional ones with the increasing number of occurrence, high frequency, increasing accumulating knowledge of its occurrence, development and evolution and the rich experience of emergency response. Because of the mistaken preparation work, it caused serious or rare secondary disasters which could turn into the unconventional emergency, such as the frequent occurrence of earthquake disaster in recent years and in 2005 the polluted water incident of Songhua River.

According to the analysis above, this paper suggested that the unconventional emergency and conventional emergency both belongs the unexpected incidents. They are interlinked each other and mutually transformed. The specific relationship is shown in figure 1 below. In addition, the unexpected incidents include some special emergencies, such as the Jumping Event of Foxconn, the campus violence cutting events, the campus poisoning events and so on. These accidents do not belong to the category of conventional emergency or unconventional emergency in the occurrence, development rules and harmfulness aspects, so they should list out separately.

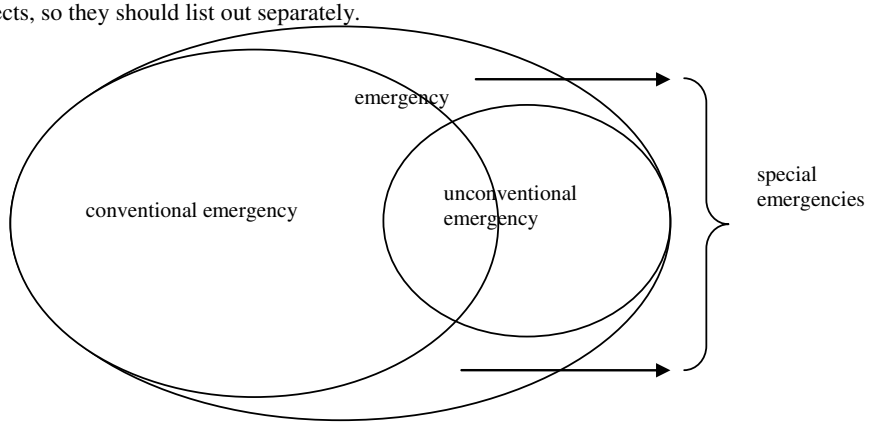

Fig. 1. Unconventional Emergency and Conventional Emergency relationship figure

3. Characteristic analysis of unconventional emergency

Compared with conventional emergency, unconventional emergency also has typical characteristics of randomness, suddenness and harmfulness. However, unconventional emergency also have the particularities in the occurrence and development mechanism, the way of evolution, effect of consequences and coping process. It's a typical and vital emergent envent which can easily lead to social chain response and serious consequences and can jeopardize social stability.

3.1. Apparent rarity and unpredictability

Unconventional emergency has apparent rarity and very low probability of occurrence mainly. This reflects in two aspects: One is that the incident occurs at a very long time interval. It maybe occur only once during ten years or even hundreds years. It also maybe the event had never happened during human history. The other aspect is that although it occurred in history, due to the social environment, geographical environment, ecological environment conditions, the occurrence of the scale has changed a lot leading to a sudden outbreak of the an event without precedent. Unconventional emergency occurs without obvious signs, such as when and where it will happen is difficult to predict. For instance, the terrorist attacks of September 11 in 2001, the spread and appearance of SARS in 2003, the global first discovered new subtype influenza virus H7N9 avian influenza in March 2013 are both never happened in the history and have apparent rarity. It is strange for cognitive and decision-making person and the precursor is not obvious, the occurrence, development and evolution are also difficult to foresee.

3.2. High derivative and chain dynamics

In the development process of unconventional emergency it often causes the occurrence of unexpected events in other areas, interacts with other events and forms a series of chain reactions. A local event may evolve into a regional event or even an international event, non-political event may evolve into a political event, and natural events could turn into social events, especially in today's globalization and information technology world it is especially true. A variety of unexpected event has its own generation mechanism and development, evolution of characteristics, lots of related factors, complex and changeable relationship. It is difficult to weigh and its evolution and development affected by the interaction between multiple cognition and decision-making person. Therefore, it has uncertainty and dynamic diverse. The evolution mechanism of single event and the coupling mechanism of multiple events are very complex and showing the complex features of the dynamic system. Such as the Chernobyl nuclear incident occurring in the former Soviet Union in 1986, due to the subject's slow decision-making and ineffective disposal, resulting in approximately 50 tons of radioactive substances released into the atmosphere and about 17.5 million people exposed to radiation in 25,000 square kilometers, led to the largest nuclear disaster in peacetime in the history. Around the Spring Festival of 2008 in southern China, occurred sleet and frost disaster. The heavy snow on the road led to the bad traffic and made it was difficult to rescue and construction. The heavy pressure of snow broke the high-voltage lines. The train was suspended and passengers and coal transportation were stranded these caused power stopped and the basic livelihood of the residents were difficult to guarantee and resulted in a variety of social problems.

3.3. Typical catastrophic consequences and uncontrollability

The most unconventional emergencies occur suddenly, resulting in heavy casualties, economic losses and catastrophic consequences, and the outbreak of the disaster has the uncontrollability. Such as "5.12" Wenchuan Earthquake caused nearly 100,000 deaths and "4.20" Ya'an Earthquake caused nearly 200 deaths both made a devastating blow to the local economy. However, the strength and intensity of the earthquake itself are beyond the control. Once the plague, SARS , H1N1 and H7N9 spread, in the lack of effective therapy, will go beyond the control and result in heavy casualties, as well as the economic impact of all walks of life. The outbreak of the 2004 Indian Ocean tsunami caused enormous human and social losses on India, Pakistan and other countries in South Asia and Southeast Asia, many, spreading to dozens of countries within a few hours. The Hurricane Katrina in 2006 also flooded the entire city and the city had to be rebuilt. The U.S. Gulf of Mexico oil spill in 2010, despite three-quarters of leakage of crude oil got clear through a variety of ways, caused a major and inevasible ecological disaster. The crude oil had permeated the food chain and even the food web of the Gulf of Mexico region, and the effect will last for several years.

3.4. Serious social panic and crisis

Due to a wide range of effect and the great economic loss of unconventional emergency, it poses serious threat to the public interest and basic social structure. In addition, the understanding of human beings for their development and evolution is always not enough; there is no ready-made contingency plan to follow. Therefore, if the situation is not controlled timely or dealt ineffectively, it is likely to cause public panic, make impact on the existing social order and even lead to social chaos and instability. For instance, during the SARS crisis, rumors and false information are spread between people who did not know the truth, making the problem more complicated and once causing social panic buying and social panic that the end of the world is about to come. The Shanxi earthquake rumor in 2010, resulted some people did not sleep at midnight in Jinzhong, Taiyuan, Luliang, Changzhi, Yangquan, etc. These people went out of the house to squeeze onto the street, "waiting for" earthquake, which brought some damage on the production and living order of the local residents. Some time ago, there continue to occur of the Sudan Red, Red-cored duck egg, Apple snails, Turbot fish, San Lu milk powder, Poison cowpea, Waste oil, Synutra milk powder, Clenbuterol, Dyed steamed buns, Artificial shark's fin, Plasticizer, Yogurt, Poison capsule and other food safety incidents, not only resulted in extremely bad social impact and serious social panic, but also directly influenced the country's image and development of foreign trade as some countries used them as the basis of as a "trade war" sanctions against China.

Due to the apparent rarity and unpredictability, high derivative and chain dynamics, typical catastrophic consequences and uncontrollability and serious social panic and crisis of unconventional emergency, bring great difficulties to the government decision-making and related rescue work. It cannot be predicted and prepared ahead based on existing knowledge and past experience. The traditional vital emergent envent decision-making model of "Prediction-Respond" is difficult to make forecasts and early warning for unconventional emergency. Special early warning method should be established to make risk identification and after the incident dynamic cognitive and response should be made according to the development and evolution of the event.

4. The explanation of entropy to the system state of unconventional emergency

From the point of view of the system science and social science, the happened evolution and emergency management process of unconventional emergency have a lot in common with the entropy evolution process of above open system. They all belong to a dissipative structure, through order to chaos, and again from chaos to order, ultimately achieve some of equilibrium. And in the process of evolution, they all have features of randomness, suddenness, dynamics and complexity. Therefore, the entropy and the dissipative structure theory can be applied to explain the occurrence of the unconventional emergency and the changing situation of the system state in the process of emergency management, as is shown in figure 2:

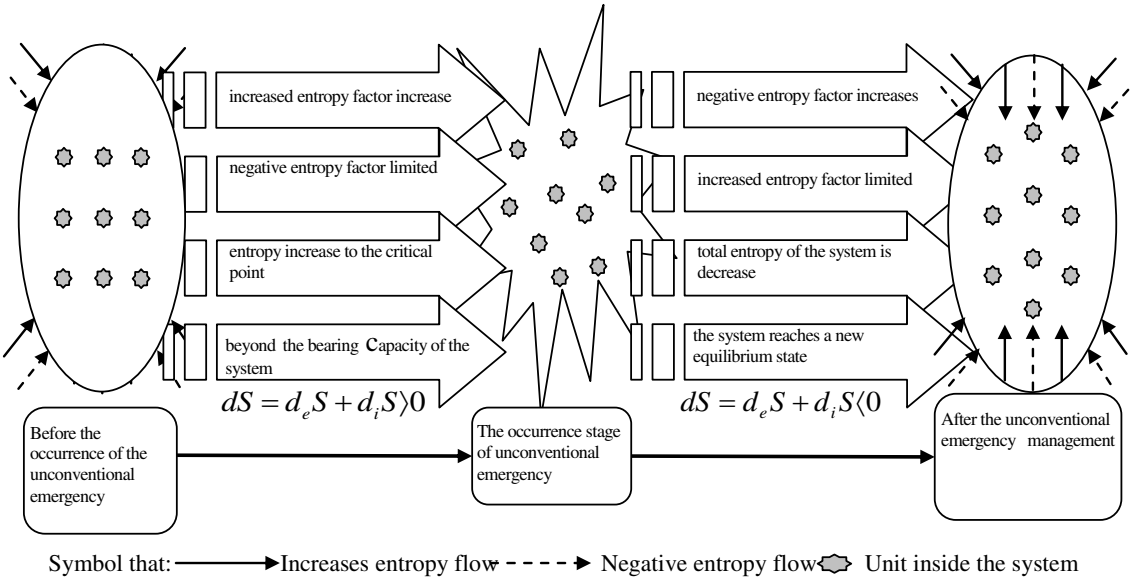

Fig. 2. System state change model diagram of before and after the unconventional emergencies happened and management

Before the occurrence of the unconventional emergency, the system under the comprehensive function of different increased entropy factor and negative entropy factor, each unit is in order and doing its own job, is in a stable and orderly equilibrium. But with the increased entropy factor of the system (such as: the deterioration of the natural environment, inadequate resources, highlight of hazards, poor management, serious corruption, the persistent rumors of public opinion, high frequency of unsafe behavior, benefit main body is blinded by gain, social panic etc.) continue to increase, more and more destructive power rapidly polymerize and inflate. And to keep the society or organization effectively operate and dissolve the negative entropy factor of the increase entropy energy (such as: human and financial resources and capital resources, management system, control measures, the coordination of organization, information flow, high-tech technology etc.) is limited and because the enhancement of the increased entropy factor can also the form the restriction of negative entropy factor. Therefore, the social self-organizing function has been gradually weakened, and the original equilibrium of system is destroyed, then it is gradually moving towards an unsteady state. As the phenomenon in the continuous accumulated, once the negative entropy forced to the lowest point, the entropy of system increase to the critical point and destructive power beyond the bearing capacity of the system, in this time a small random disturbance factors (namely fuse events) can cause the all-around burst of unconventional emergency, the brittle fracture will happen in the social organization system. Therefore, according to the entropy principle and the theory of dissipation structure, the essence of the occurrence of unconventional emergency is a process of entropy increase. Although it is in an open system, the sum of the two parts, the exchange entropy flow d_eS of the system and the surrounding environment and the entropy flow d_iS produced by changes of the internal system is greater than zero, which means the entropy increase is bigger than the entropy decrease and the total entropy of the system is still increase. When the contradiction of causing unconventional emergency accumulate to a certain degree, once the sum of system entropy and events which directly decided potential incident over the critical point, the system balance will be broken, which can lead to the occurrence of unconventional emergency. The system enters an unsteady state from order state and then enters in a state of disorder and confusion.

In the occurrence stage of unconventional emergency, the system's total entropy value achieves to the maximum status, the system is in the most chaotic state, the unconventional emergency is most difficult to control and the transfer of the social resource from all walks of life is also difficult to achieve in a short time. But at this time due to the existence of the people the highest organization unit in the world, the system does not give up the efforts of the self-organizing function for system repairing. Under the action of people, various negative entropy factors which are beneficial to social healing (mainly the management measures of unconventional emergency) are stimulated by the unconventional emergency appear new resources, information, staff, technical and restructuration of organizational form the strength combination of the negative entropy factor, enhance the ability of dissolving the entropy energy, gradually reduce the increased entropy energy and its impact and make the system to reduce the total entropy. The system enters back into the state of orderly social operation scope from extremely chaotic state and forms a new balance and dissipation structure. Therefore, according to the entropy principle and the theory of dissipation structure, the essence of the emergency management of unconventional emergency is a process of entropy decrease. In the management process, through mobilizing various resources of the social system, make the sum of the two parts the sum of the two parts, the exchange entropy flow d_eS of the system and the surrounding environment and the entropy flow d_iS produced by changes of the internal system is less than zero, which means the entropy increase is smaller than the entropy decrease and the total entropy of the system is decrease until it reaches a new equilibrium state, system enters into the order state from a chaotic state gradually.

From the entropy explain of the above unconventional emergency system state, in order to maintain a system in a stable and orderly operation condition, the system should form a good dissipative structure, and to reduce and eliminate the increase entropy, creating and introducing negative entropy as far as possible. Therefore, the prevention and emergency management process of unconventional emergency must strengthen the negative entropy factor, control the increase entropy factor, try to introducing negative entropy flows, in order to reduce the total entropy to maintain the orderly system structure and increase the material and energy exchange between original system and external environment in order to maximize the realization of matter and energy dissipation. To achieve orderly space, orderly time and orderly function, then obtain the biggest security benefits.

5. Temporal framework of unconventional emergency decision-making

According to the above occurrence of unconventional emergency and system state changes situation in the process of emergency management, evolutionary process of unconventional emergency can be divided into five periods including incubation period, initiation period, outbreak period, evolution period or recovery period and disappeared period. Temporal framework of its emergency decision-making can be showed in Figure 3, which indicates dynamic cyclical process of system entropy value, also indicates that nature and content of unconventional emergency decision-making work also changes constantly with different entropy state situation.

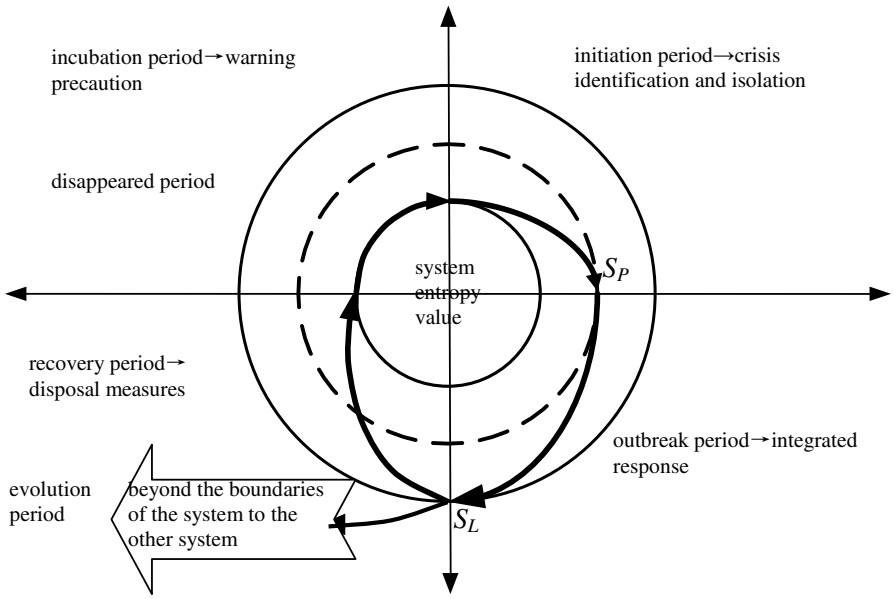

Fig. 3. Every stage of the unconventional emergency system status and the corresponding emergency decision-making temporal framework

(1) In an initial incubation period of the event, system entropy value is smaller and in a smooth and orderly state which describes the system as a whole is well structured and there is only possibility of triggering unconventional emergency. Emergency decision-making work in this period is mainly to make early warning precaution on the use of monitoring and control, the establishment of plans in order to effectively prevent and avoid the occurrence of unconventional emergency.

(2) If there is not an effective early warning precaution in the incubation period, the system will enter into the initiation period. The system entropy value has a faster growth relative to the incubation period, but still below S_P which is the threshold of events outbreak. It produces symptoms of an outbreak of unconventional emergency or appears fuse events of unconventional emergency outbreak. This period accumulates some contradictions of trigger unconventional emergency and shows them in a certain way. So the period is the best time to effective control of unconventional emergency outbreak or minimizes event damage, as well as the critical time of the most challenging moment. Emergency decision-making work must grasp disposition time, identify and judge the precursor of various crises in the first time and take all possible quarantine measures as much as possible to reverse or reduce the crisis situation, and control the crisis within the scope of control.

(3) After initiation period, if the principal contradictions in the crisis have not been effective in controlling, crisis will further upgrade. System entropy value constantly grows until over S_P which is the threshold, then unconventional emergency outbreak. System entropy value still increases constantly and begins to fall into the state of disorder and confusion. At this time, people often cannot take measures to respond, or even has taken measures but the effect of response also cannot immediately effective. After a period of time, system entropy value increased to S_L which is the peak value, unconventional emergency fully exposed and system almost in paralysis stage and the harm also reached maximum. In this period, emergency decision-making work entered a comprehensive and integrated response period, crisis disposal mechanism with unified command, sensitive reaction, completed function, orderly coordination and efficient running must be established. The emergency response plans must be implemented and all forces should be invested and urgent mobilized in emergency rescue. This means to maximize the matter and energy between external environment and the original system. Negative entropy flows should be introduced to limit the increase factors of system entropy and reduce the total system entropy.

(4) After effective emergency rescue the system entropy value begins to slowly decrease, and emergency measures start to see the results, but the entire system is still in a very critical state. Once there are improper disposal measures it will trigger a new outbreak of the crisis, so the events develop beyond the boundaries of the system and enter the dangerous evolution period. Conversely, if the proper measures have been taken, the system entropy value will gradually fall below S_P which is the threshold, and it will develop a new ordered balanced state, thus unconventional emergency entry into the

recovery period. Crisis is over in this period, but emergency decision-making and management did not end. It needs to recover and reconstruct the devastation caused by the crisis, investigate the causes of the crisis, assess the damage caused by the crisis and formed suggestions for improvements, in order to turn crisis into opportunity, and promote institutional improvement, structural adjustment and political improvement.

(5) Finally, with the continuous advancing of disposal measures, system entropy value further reduce and recover to normal state. Unconventional emergency faded gradually, system changes from emergency state to normal state and emergency decision-making is gradually converted into regular decision-making.

Visible on fully mechanized, with continues advancing of unconventional emergency system evolutionary state, the form and content of the emergency decision-making work are constantly changing. And once the decision-making incorrectly in the process of emergency decision-making, the event will expand constantly, even beyond the boundaries of the system, and trigger the new outbreak of the crisis of other systems. Thus, while the system entropy value will decline with the input of the emergency work in this system, the system entropy value will rise in other evolved systems.

6. Conclusions

(1) Definition and characteristics analysis of unconventional emergencies, based on the principle of entropy and dissipative structure theory, analysis of unconventional emergencies and emergency management in the process of entropy state changes, considered that the unconventional emergencies happened and management is an Open dissipative system. System entropy changing by increased entropy factors ZS, negative entropy factor FS and system bearing capacity C combined action. Further illustrate the unconventional emergency warning and emergency management must strengthen the negative entropy factor and control increase entropy factor, trying to introduce negative entropy flow, enables the system to form a good dissipation structure, in order to make system balance regional and ideal stability.

(2) Based on entropy of interpretation of unconventional emergency system state, analysis unconventional emergency decision-making temporal framework. Considered that corresponding system of unconventional emergencies in the process of incubation period, initiation period, outbreak period, evolution period or recovery period and disappeared period, the form and content of emergency decision-making work also in constantly changing, the temporal framework can be divided into warning precaution, crisis identification and isolation, integrated response and disposal measures.

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